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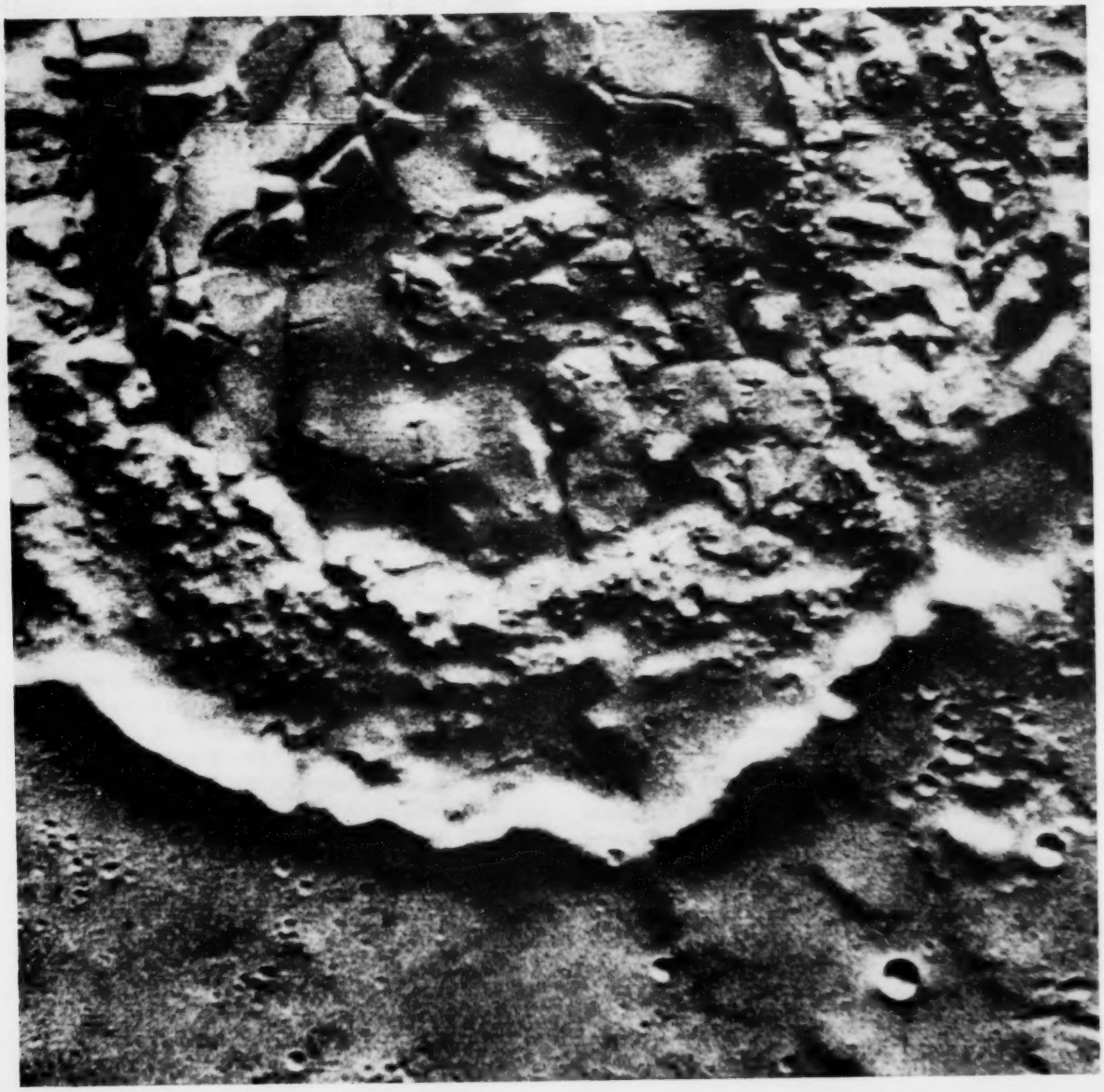

COVER

Spectacular View of Martian Surface— Ten times the size of Arizona's Grand Canyon, Capri Chasm is estimated to be some 32 kilometers (20 miles) wide and 1,900 km. (1.2 miles) deep. The photograph was taken by Viking cameras from orbit around Mars on July 3 when the spacecraft was 1,195 km. (1,240 miles) above the Red Planet. Rockslides, cracked terrain and huge boulders can be seen. Capri Chasm is near a substitute landing site for Viking, under consideration in July after camera scrutiny had ruled out Chryse, the original site chosen for a July 4 landing.

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Letter from Washington

Dear Colleagues:

Please let this letter serve as an introduction and a means to introduce myself to some of you whom I have not had the opportunity to meet. I assume my new NASA assignment with a great deal of pride and an equal amount of humility. It is a position given great distinction by George Low and his predecessors who served NASA, and NACA before it, as this country developed the aeronautics and space capabilities that today make us preeminent in the world.

Lovelace

I find that as I assume my new responsibilities I share with you a rich legacy left by my predecessors. In Hugh Dryden, the first Deputy Administrator, NASA was favored with the brilliant blending of spirit and pragmatism that motivate the individual to fully use his talents and material resources. Cheerfully, with tact and consideration, Dr. Dryden imbued this agency with a true sense of reason for being. His philosophy was built on a structure of principles that I believe in. I have discovered that I have long suffered an acute case of "Drydenism." I find it useful and you may share my thought that it would be fitting to remind ourselves of some of the key elements of that philosophy.

From the evolution of aeronautical excellence to our historic ventures in space, the Dryden concept of achievement was based on the importance of the individual human intellect. He constantly strived for and took great pride in the fact that so much talent had been assembled in this agency. He firmly believed that it was NASA's responsibility to find the finest scientific and managerial minds in business and industry, and to cause them to excel on behalf of our country. I share his belief and believe that we all should strive to motivate our bright young minds to follow his lead.

Another part of the Dryden concept was that if we are to retain our excellence in research and applications, we must maintain a strong "hands-on" attitude. The individual at NASA should be a "doer" of things and not just a "watcher." A job must never become just that—a job. We must work to insure that our people are not just involved; they must be committed. This small agency has performed wonders, and there are more to come.

Dr. Dryden also believed that it was necessary to establish clear and concise goals for all of our endeavors, and that this in turn stimulated progress and creativity. The Apollo program, with its precisely stated goal, bears witness to the validity of this premise. If we in NASA are to achieve future successes, our efforts must be directed toward similarly well defined goals.

Finally, Dryden was very much ahead of his time in the importance he placed on the social responsibility which those who conduct R&D have to our society. Therefore, in keeping with our dedication to excellence, we need to remind ourselves of our social responsibility in the employment of the things we do and in the research we conduct.

In space, we are programmed and ready for the next adventure. The Space Age has passed through two phases and it now stands at the threshold of the third. The first I will call the Goddard period, the exploratory stage that began 50 years ago when Dr. Robert Goddard launched the first liquid-propellant rocket from a remote New England farm.

The second phase was our mastery of the elements of space. Apollo, born of Mercury and Gemini, ascended to heights that even Galileo could not have dreamed of.

Now, in the third phase, in addition to continuing our planetary exploration to learn more about the universe, we are about to utilize the new frontier of space to the furtherance of our earthbound needs. To capture this promise will require that we take the confidence inspired by the Apollo program and the wisdom that it germinated, and extend them to serve the needs of humanity. Within a few years, the Shuttle will be performing as the major element in the Space Transportation System. We will then see this capability used for such diverse things as manufacturing, the maintenance of our planet, and the source of important new scientific knowledge.

Science and engineering, like good music, have no international boundaries. The national space program increasingly embraces other countries to the mutual benefit of mankind. Foreign instrumentation is being constantly carried into space by the Delta, Scout and other NASA launch vehicles. It is significant that the Spacelab, product of the European Space Agency, will be among the first payloads flown on the operational Space Shuttle.

Because of a series of unforeseen events, this has become a time of decision for aeronautics and the U.S. aerospace industry. Although we lead the world in the production and sales of aircraft, we are by no means assured of this position in the future. It is imperative, therefore, that we address high-risk technology development in the near term as it relates to fuel conservation, safety, and noise and emission reduction; and, in the

long range, our goals must be those of increased performance and productivity at a lower technical and financial risk. Only in this way will we continue our leadership of the world's aeronautics industry.

In all of these efforts, let us go back to Dr. Dryden's initial premise that it is the collective intellectual capacity of NASA which generates the capability to define goals, to plunge into vital efforts, and to exploit technological advances for the benefit of all people. If each of us will, in all things, strive for uncompromised excellence, we cannot fail. To that end, I look forward to working with you to meet the challenges ahead.

Sincerely,

A. M. Lovelace

A. M. Lovelace
Deputy Administrator

Monthly NASA Highlights

Air-Space Museum Opens

The exciting new National Air and Space Museum on the Mall in Washington, D.C., was formally dedicated on July 1. President Ford opened Washington's newest museum—a part of the Smithsonian Institution—calling it a 200th anniversary present for the nation.

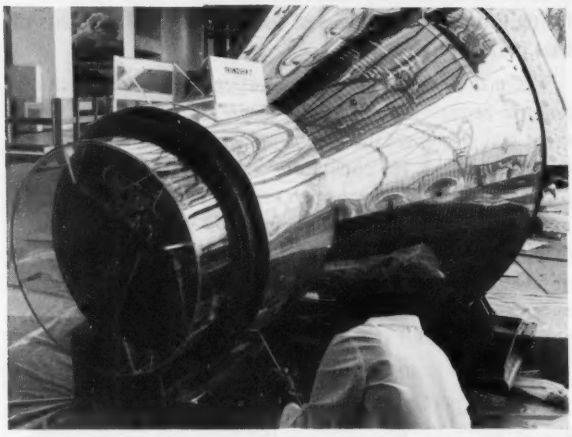
The ribbon-cutting following the President's remarks was done on a signal from the Viking 1 spacecraft orbiting Mars. The signal actuated the mechanism used in severing the ribbon.

The President was introduced by Chief Justice Warren Burger in his capacity as Chancellor of the Smithsonian. Joining them on the speaker's platform were the Regents of the Smithsonian, including Vice President Rockefeller, and Secretary S. Dillon Ripley.

Mr. Ripley introduced the Chief Justice; the Rt. Rev. William F. Creighton, Episcopal Bishop of Washington, delivered the invocation.

The program was preceded by a fly-over by the Thunderbirds, the Air Force precision flying team.

Observers and commentators almost without exception used superlatives to describe the imposing building and its displays, calling the museum "a stunning exhibition showcase," "a means of telling the marvelous

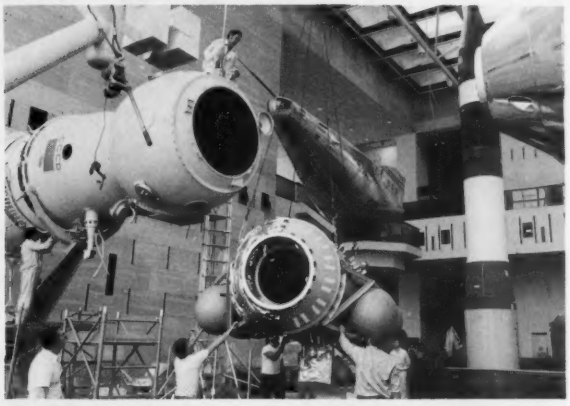


First Manned Launch Vehicle—Astronaut John H. Glenn's flight in the "Friendship 7" on Feb. 20, 1962, marked the beginning of NASA's manned orbital launches. Glenn was in orbit on the Mercury spacecraft for four hours and 55 minutes. Photo shows the original module being readied for display at the National Air and Space Museum.

story of man and his flying machines," "a wonder," and "a dignified, handsome work of architecture—an appropriate and harmonious finale to the grand architectural concept on the Mall."

Apollo 11 astronaut Michael Collins, director of the museum, said: "This, in its way, was like launching a miniature Apollo—of course, moving the decimal point a few places to the left for less cost. We worked on an Apollo timetable to get a man on the Moon by the end of the decade. This project was to get a museum on the Mall by Bicentennial time."

Many of the exhibits, which take visitors from the sand dunes of Kitty Hawk to the Moon landings, delineate NASA programs and accomplishments. Among them are: a Moon rock that visitors may touch; a walk-through Skylab Orbital Workship, a copy of the space laboratory where astronauts lived for three months in space; a mock-up of an astronaut in a space capsule; a Saturn V engine; the Apollo command module; the Soviet Soyuz spacecraft; the Lunar Roving Vehicle; and many films, photographs, artwork and other illustrations of the space effort.



Apollo and Soyuz Meet Again—One of the displays at the new National Air and Space Museum features the American and Soviet spacecraft that docked in space in July of 1975, during the Apollo Soyuz Test Project. Seen here is the Apollo being lifted to mate with Soyuz. Soviet specialists were on hand to assist in the project.

Not only an exhibition center, the museum has a theater with a screen seven stories wide and five stories high, seating 485 persons in tiers; a "spacearium" that projects 9,000 stars, the Milky Way, wispy night clouds, comets and the Earth as seen from orbit—on a dome that measures 21 meters (70 feet) in diameter; an art gallery; and a library (open to students) containing 20,000 volumes.

The Air and Space Museum expects to have seven million visitors a year at a rate of some 20,000 daily. NASA headquarters employees were privileged to visit the museum on July 6, from 7:30 a.m. to 10:00 a.m., during a special opening preceding the customary 10 a.m. opening to the public.

Moon Buggy—The lunar roving vehicle, called by one newspaper "the merry moonmobile," was first used on the Apollo 15 Moon mission. Astronaut David R. Scott and James B. Irwin logged more than 18 hours of travel in the vehicle from their Moon base on the Marsh of Decay to the foothills of the 4,500-meter (15,000-foot) Spennine Mountains and the 1.6 km. (one mile) wide, 180 to 360-m. (600 to 1,200-foot) deep Hadley Rille. The Moon rover is now on display at the National Air and Space Museum.

Einstein Theory Tested in Space

A clock-carrying space probe was launched June 18 on a suborbital mission to test a fundamental aspect of Einstein's general theory of relativity. The experiment, known as Gravity Probe-A or the Red Shift Experiment, a joint program of the NASA Marshall Space Flight Center and the Astrophysical Observatory of the Smithsonian Institution, was the first test in space to explore the structure of space and time.

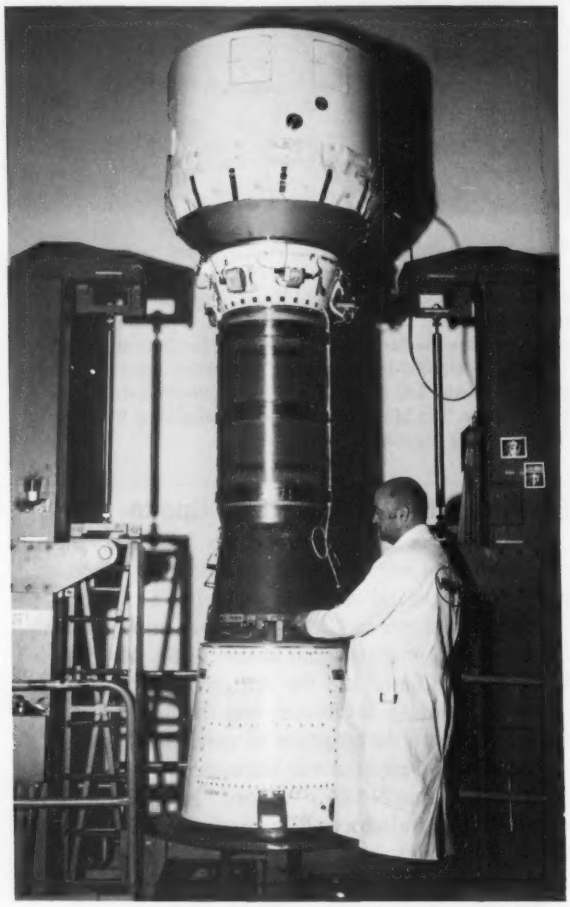
The scientific payload was launched by a four-stage Scout rocket from NASA's Wallops Flight Center into an elliptical flight trajectory of one hour and 55 minutes before falling into the Atlantic Ocean. Maximum altitude was 10,000 kilometers (6,200 miles).

The rates shown on the rocket-borne clock—an extremely accurate hydrogen maser atomic clock—were compared by telemetry with those seen on an identical reference clock at the Merritt Island launch area at the Kennedy Space Center. According to the Einstein theory, the frequency of the clock in the probe, as observed by telemetry, should always appear faster than that of the ground-based clock.

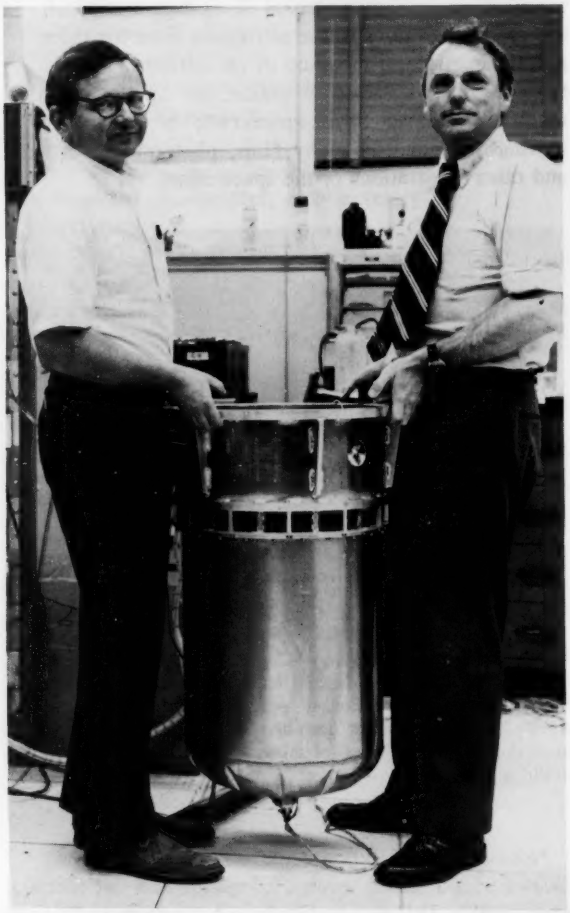
The theory's "equivalence principle" states that, within a limited region of space, every form of acceleration is indistinguishable from a gravitational field. Newton showed that, in the absence of an acceleration, every object moves in a straight line at a constant speed. The relativity theory generalizes this by stating that every body affected only by a gravitational field moves along a path in four-dimensional space-time, comparable to the motion along a straight line with constant speed in the absence of the field. Because (as viewed in three dimensions) the path of a body in the region of a large mass (such as the Earth) is not a straight line, but is deviated toward the mass, physicists say that space-time is "warped" in the presence of the large body.

In the gravity probe mission, all payload systems seemed to have functioned properly, NASA officials report. Several months of data evaluation will be required to assess the accuracy of the test and to determine whether the scientific objectives were fully met.

Smithsonian principal investigator Dr. Robert Vessot said that the experiment is "pure science," the purpose of which is to prove a long-standing theory first advanced by Einstein in 1915. He said he believes the data to be gained from the experiment will help us to better understand the Universe and may even provide a better understanding of such phenomena as "black holes." Dr. M. W. Levine, also with the Smithsonian, was co-investigator.



First Time and Space Test in Space—NASA's suborbital Relativity Gravity Probe mission was successfully launched last June at Wallops Flight Center. Photo shows the Gravity Probe-A—a clock-carrying space probe to test the Einstein theory—attached to its Scout launch vehicle at the Wallops center. The payload's atomic hydrogen maser functions as a clock of extraordinary stability and accuracy. Parker Johnson of the Vought Corp. makes a small adjustment.



Gravitational Questions May Be Answered—The Red Shift Experiment, designed to test Einstein's "space-time warp" theory, was directed by co-investigators M. W. Levine (left) and Robert Vessot of the Smithsonian Institution. The two hold the atomic clock that later was installed in the spacecraft.

Astronomy Balloon Flight a Big Success

A scientific instruments package containing, in all, about a ton of equipment recently drifted across central Texas skies for 12 hours gathering information on stars, including far distant giant and super-giant stars.

The flight was called by its U.S. and Dutch designers "the most successful balloon flight of its type ever conducted." The experiment capped a three-year collaboration between the NASA Johnson Space Center and the Space Research Laboratory at Utrecht, the Netherlands.

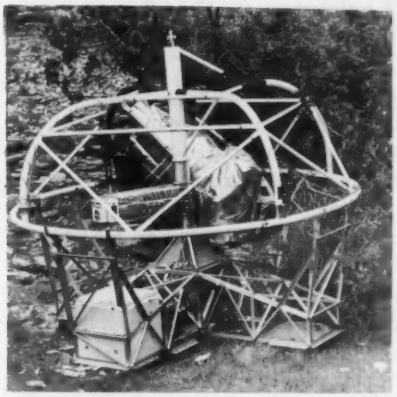
Dr. Yoji Kondo, JSC astronomer and co-principal investigator for the United States, said the flight—the seventh in a series of star studies that began in 1971—was the best yet. The 600-kilogram (1,300-pound) package of instruments was launched by a balloon roughly the size of a football field, filled with 560 cubic meters (20 million cubic feet) of helium, from the National Center for Atmospheric Research at Palestine, Texas.

The experiment, called BUSS (for balloon-borne ultraviolet steller spectrometer), was lifted to an altitude of 40 kilometers (25 miles) by the balloon, well above the Earth's atmosphere where the instruments had a clear view of the stars. As the balloon floated westward during the night, data on 16 separate stars were gathered and radioed to the ground station where scientists monitored the incoming information and controlled the airborne instruments.

Afterward, the entire payload was lowered to the ground by a 26-meter in diameter (85-foot) parachute similar to those used on the Apollo command module. Payload, chute and balloon were recovered by NASA engineers.

Star Tracks—A camera aboard the gondola of the BUSS payload took this 25-mile-high, time-exposure sweep of the night sky over east Texas. Light streaks in top two-thirds of the picture are star tracks, the dark band is the Earth horizon and atmosphere, and the lower white streaks are clouds.

Dr. Kondo said the BUSS package can gather information on spectral variations of numerous stars and thereby aid scientists in gaining insight about star structure and evolution. He cited information gathered on one particular star as an example: BUSS instruments revealed that the super-giant star "Deneb," in the Cygnus (Swan) constellation, is 1,400 light years away. (That means that its light as seen on Earth was emitted far back in history, about the time the 11th century began.) Kondo said that Deneb is so large—much larger than the Sun—that if the Sun could be imagined as in Deneb's center, Earth would orbit the Sun within the star's periphery. The brightly burning Deneb, he said, is losing at least several quadrillion tons of matter each year.



Star-scanning Payload Returns to Earth—BUSS payload cage with instruments nested securely inside as it was found by a NASA search team. The payload, chute and balloon landed safely at Ranger, Texas, midway between Abilene and Fort Worth.

Other stars scanned during the recent flight were Arcturus, a giant star in the Bootes constellation, super-giant star alpha Scorpii (Antares), alpha Lyrae (Vega) and alpha Virginis (Spica). Virginis is an extremely hot star and one of the brightest observed by BUSS instruments.

The Dutch team, led by the internationally prominent scientist Dr. Cees de Jager, has returned to the Netherlands to study the information obtained. Dr. Kondo, with co-investigators Drs. Thomas H. Morgan of JSC and Jerry L. Modisette of Houston Baptist University, also are at work on the data collected and on plans for another balloon flight to be launched some time this fall.

The Lockheed Electronics Company furnished technical and operational support for the program. The Lockheed team leader was Curtis Wells. David White of JSC was the NASA engineering manager. The launch balloon was made by Winzen Research, Inc. of Texas. ■■■■■

NASA Takes Part in Ocean Study

Spacecraft, aircraft and watercraft teamed up in a recent inter-agency survey of the Gulf Stream through use of remote sensing techniques. The over-the-Atlantic site was about 580 kilometers (300 miles) east of the lower Delmarva Peninsula.

Program objectives were to test the ability of various remote sensors, including active and passive microwave radar, and to measure the boundaries and other factors related to the Gulf Stream, whose warm currents strongly influence the environment in and over the Atlantic Ocean.

Participating in the experiment were NASA's Wallops Flight Center and Langley Research Center; the National Oceanic and Atmospheric Administration; the Naval Research Laboratory; the Cape Fear Technical Institute (N.C.); and North Carolina State University.

Remote sensors on a NOAA weather satellite and on NASA's Geodynamic Experimental Ocean Satellite (GEOS-3) were used to obtain infrared "signatures," which identify Gulf Stream boundaries, and to measure current velocities. The project was organized around a scientific research task directed by NASA's Office of Applications.

The sensing techniques used in the series of experiments undertaken promise to provide global-scale measurements of the Earth environment in near real-time. In the oceans, the traditional methods of observation involving ships, buoys or other platforms as collectors of required information cannot provide data on fast-changing or large-scale phenomena.

Scientists have long been interested in reaching a better understanding of the Gulf Stream. It carries a tremendous amount of heat energy over thousands of miles of ocean waters, it has a significant effect on the global balance of energy in the atmosphere and the ocean, and it carries great quantities of nutrients that strongly influence fishing conditions and marine life. The Gulf Stream affects weather and climate, as well as the movement of coastal waters.

Ancestor of Space Shuttle

An old film clip shows startling similarities between the Space Shuttle concept and a pair of French aircraft flown in the 1940s.

A short 16-millimeter film brought back from France in the 1950s by engineer Jim Useler—an employee then at the Lewis Research Center, now deceased—displays a remarkable series of tests of a Ramjet jet-propelled airplane. The craft, riding piggyback on an airborne transport, was the invention of French aeronautical pioneer Rene Le Duc.

Le Duc began his experimentation with jet propulsion in the 1930s and tested a design concept of a piloted jet aircraft in 1936 in France. The tests were so impressive that the French Air Ministry awarded Le Duc a contract for the study and construction of an experimental plane that could be launched from a carrier transport plane during flight.

By 1940, all components were ready for what Le Duc designated the 010 Ramjet airplane, but the outbreak of World War II and the fall of France halted all progress. Le Duc hid his material and equipment in southern France until such time as work could be resumed.

After the war, Le Duc retrieved the components of the jet-powered craft and made his first flight test of the 010 in 1949. Its success clearly demonstrated the merits of his Ramjet airplane. His piggyback design entailed raising the 010 into position with a crane so it could be placed atop the transport craft. The 010 then was attached to two pylons at the forward position of the transport; the rear portion of the 010 was locked to a support crane built on the back section of the transport. The pilot boarded the 010 through a hatch, which closed behind him. When the transport plane had reached the required altitude and speed, it dropped away from the 010, whose Ramjet engines were then ignited. Later the 010 landed without power and glided to a safe stop. The prototype of the 010 is now on display at the Air Museum in Paris.

Craft Separate in Flight—In a photo that looks not unlike an artist's concept of the Space Shuttle, a transport plane drops away from a Ramjet in a 1949 test over France. Jet engines were fired after separation to propel the smaller plane to landing fields. It glided in on landing, without aid of engines. Ramjet engines could not be started from a dead stop, but had to be ignited in flight.

During the 1950's, Le Duc improved on his original design with the Ramjet 021. He had sacrificed a great deal of efficiency on his first design to achieve the necessary air dynamics. Tests had revealed, for instance, that visibility was poor on the 010. Accordingly, he extended the viewing capability of the pilot by building a transparent, wrap-around cockpit in the 021. He also added wheels to the Ramjet's wing tips for better stability and balance on landings.

Numerous test flights, all successful, were made in airfields near Marseilles, following the basic principles of the 010—a jet-propelled plane carried piggyback on a transport plane, then released and engines ignited, with a glide landing at flight termination.

Unfortunately, Le Duc's concepts, though brilliant, unconventional and visionary in the 1930s, had become outmoded in the 1950s by rapid advances made in aeronautics and jet propulsion during and after the war. The technology developed in Germany, England and the United States had outstripped the pioneering Ramjet and French national emphasis on further developmental technology shifted to other designs.

A Couple of High Fliers of Yesteryear—A French "Ramjet" hitched to the top of a transport plane was one of the earliest jet-propelled aircraft. Developed by Rene Le Duc, French aeronautics innovator, the jetcraft was a novelty in the 1930s.

President Ford Hails Bicentennial Exposition—NASA Administrator Dr. James C. Fletcher listens to a message from President Ford, who addressed guests and sent greetings and best wishes on the dedication of Third Century America in mid-June at the Kennedy Space Center. The exposition on science and technology is the only government-sponsored exposition held during the Bicentennial year.

Minority Businessmen Meet—Conrad Walker (center) of MSFC's Equal Opportunity Office talks with Russell Brown (left) and Nathaniel Griffin, respectively vice president and president of D. P. Associates, Inc., at the Minority Business Exposition held recently in Huntsville. In attendance were owners and managers of minority businesses, majority corporations and government procurement agents. The exposition was sponsored by the Black Business Improvement Association and the Northern Alabama Business Development Organization.

Prospectus

Manned Space Flight: Projects Mercury and Gemini

Manned flight to the Moon followed by safe return to Earth was the goal of the U.S. space program during the 60s. To achieve that goal, NASA divided its manned space flight program into three steps or projects—Mercury, Gemini and Apollo

Project Mercury put one-man spacecraft into short-duration controlled Earth orbit to investigate man's performance capabilities and capacity to withstand the environment of space and to test and successfully recover the vehicles.

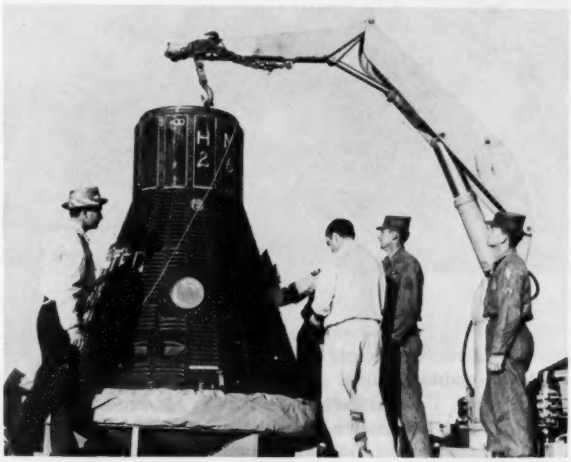
Project Gemini also fulfilled its original objectives—among them, extending orbital missions up to two weeks at a time with a two-man crew, and developing the techniques for orbital rendezvous and docking, in which two space vehicles are maneuvered close together and finally joined.

Earliest "Astronauts"—Chimpanzees were passengers on some of the Mercury-Redstone flights in the early 1960s. "Ham" made the first suborbital flight on Mercury-Redstone 2, Jan. 31, 1961; "Enos" made an orbital flight on Nov. 29, 1961.

That same technique of orbital rendezvous—but around the Moon instead of Earth—enabled astronauts in the three-man Apollo spacecraft to achieve lunar landings.

Project Mercury became an official program of NASA on Nov. 26, 1958. The Space Task Group, a NASA team responsible for the agency's early manned space flight programs, was formed at the Langley Research Center, Hampton, Virginia. Seven astronauts were chosen in April 1959 after a nationwide call for jet pilot volunteers.

The Mercury spacecraft was designed and built with a maximum orbiting weight of about 1,450 kilograms (3,200 pounds). Shaped somewhat like a bell, the craft was 1.89 meters (74.5 inches) wide across the bottom and about 2.74 meters (9 feet) tall. The astronaut escape tower on top added another 5.18 meters (17 feet) for an overall length of 7.92 meters (26 feet) at launch. Two boosters were chosen—the Army's Redstone, 35,380 kilograms (78,000 pounds) thrust and Air Force's Atlas, 163,290 kilograms (360,000 pounds) thrust—for suborbital and orbital flights, respectively. Before the manned flights began, Ham, the chimp, was a passenger on the successful suborbital Mercury-Redstone 2 (MR-2) flight on Jan. 31, 1961.



Preparing for Manned Flight—Return of the Mercury Redstone 2 capsule Feb. 1, 1961 at Cape Canaveral. "Ham," the first chimpanzee in space, was aboard at splashdown in the Atlantic Ocean. He was in fine fettle when released from the capsule.

Then all was ready for the historic MR-3 flight.

At 9:34 a.m. on May 5, 1961, as about 45 million Americans sat tensely before their television screens and watched, a slim black-and-white Redstone booster, capped with a Mercury spacecraft manned by astronaut Alan B. Shepard, Jr., lifted off its pad at Cape Canaveral and roared through blue sky toward black space.

At 2.3 seconds after launch, Shepard's voice came through clearly to Mercury Control; soon afterward the millions heard the historic transmission:

> "Ahh, Roger; lift-off and the clock is started . . . Yes, sir, reading you loud and clear. This is Freedom 7. The fuel is go; 1.2 g; cabin is 14 psi; oxygen is go . . . Freedom 7 is still go!"

America's first manned space flight lasted 15 minutes and 22 seconds and was weightless a third of that time. Freedom 7 rose to an altitude of 187.48 kilometers (116.5 miles), attained a maximum speed of 8,334.62 kilometers (5,180 miles) per hour, and landed 486 kilometers (302 miles) downrange from the Cape. Shepard experienced a peak stress of 6 g during booster acceleration and less than 12 g on reentry. Recovery operations went perfectly, the spacecraft was undamaged and Shepard was exuberant and in excellent condition.

The "unqualified" success of the Shepard suborbital flight brought immense joy and satisfaction to the managers, engineers, associates and astronauts of the Space Task Group. They had labored almost two and a half years for this first triumph. Flight failures, schedule slippages, press criticism, and most recently, the U.S.S.R's attainment of the first orbital flight, all had tempered the pride of the Mercury team. But on May 5, 1961, the nation rejoiced with relief and pleasure in the success and safety of Alan Shepard.

On May 25, President Kennedy presented a special message to Congress on "urgent national needs":

> "Now is the time to take longer strides—time for a great new American enterprise—time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on Earth. . . . I believe this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth."

The Congress, believing that the American people were also ready to support an expanded and ambitious long-term space exploration program, quickly endorsed these words from President Kennedy. Project Apollo shifted from a circumlunar expedition plan to a lunar landing endeavor, to be achieved before 1970.

An Historic "First"—Alan B. Shepard, the first American to fly in space, is shown being recovered by a U.S. Marine Corps helicopter team after splashdown from his May 1961 15-minute suborbital mission aboard Freedom 7.

On July 21, 1961, astronaut Virgil I. "Gus" Grissom made the second ballistic flight in Liberty Bell 7, ending the Redstone tests and advancing the Mercury-Atlas (MA) series of flights to orbital missions. Before the first manned attempt, however, another chimp, Enos, made an orbital flight (MA-5) on Nov. 29, 1961.

Astronaut John H. Glenn, Jr. was the first American to orbit the Earth. His capsule, Friendship 7, was launched aboard Atlas 109-D (MA-6) at 9:47 a.m. on

Feb. 20, 1962, and completed three revolutions before splashdown in the Atlantic.

On the MA-7 mission on May 24, 1962, astronaut M. Scott Carpenter in Aurora 7 completed another three-orbit flight.

MA-8 of Oct. 3, 1962, doubled the flight time in space as astronaut Walter M. Schirra, Jr., orbited six times, landing Sigma 7 in the Pacific recovery area instead of the Atlantic.

Finally, on May 15-16, 1963, astronaut L. Gordon Cooper, Jr.'s Faith 7 completed a 22-orbit mission of 34½ hours, triumphantly concluding the flight phase of Project Mercury.

Originally, Project Mercury was assigned only two broad missions by NASA—first, to investigate man's ability to survive and perform in the space environment; and second, to develop the basic space technology and hardware for manned space flight programs to come.

Among the significant aerospace medical information derived from Mercury were:

- Consumption of food and beverages and sleeping during space flight were proved possible.
- Radiation dose received by the astronaut was considered medically insignificant.
- All measured physiological functions remained within anticipated ranges throughout all flights. There was no significant degradation of pilot function attributable to space flight.
- There was no evidence of abnormal sensory, psychiatric, or psychological responses to space flight.

The following were also accomplished in Project Mercury:

- Development of a NASA management system that could carry out more advanced manned space flight ventures.
- Exploration of the fundamentals of spacecraft reentry.
- Starting a family of launch vehicles from existing rockets that led to new booster designs.
- Setting up an Earth-girdling space tracking system that was later modified for the Gemini and Apollo projects.
- Training of a pool of astronauts that could be augmented to meet the requirements of future space exploration.

Project Gemini

Project Gemini was the second step in achieving the goal of putting American astronauts on the Moon and returning them safely before 1970.

Gemini's mission was concerned with development of spacecraft and launch vehicles, extension of the ground procedures for tracking, communications and control, and preparation of astronauts for operations of ever-increasing complexity and difficulty. Since it was to be flown by a crew of two astronauts, the project was named Gemini for the constellation twins Castor and Pollux.

NASA decided to follow the Mercury's basic "capsule" design for Gemini spacecraft, saving time and engineering efforts. But the two-man craft was wider at 3 m. (10 feet), taller at 5.8 m. (19 feet), and more than twice as heavy at 3,764 kg. (8,300 pounds). These dimensions provided 50 percent more cabin space, making room for much new equipment and with it far greater performance flexibility.

Since Mercury's Redstone and Atlas boosters lacked the power to orbit the heavier two-man craft, a modified version of the military Titan II became the Gemini Launch Vehicle (GLV), with a total thrust 240,406 kg. (530,000 pounds). The hypergolic (self-igniting) propellants used were non-explosive, an astronaut safety factor.

Chosen for Gemini's prime mission of orbital rendezvous and docking was the Agena-D target vehicle, a modified version of the reliable Agena-B second stage that, with Thor or Atlas boosters, had orbited many satellites and launched unmanned Mariner and Ranger probes. Agena's "stop-and-restart" rocket engine, capable of cutoff and reignition at least four times, was important for maneuvers with Gemini.

Agena-D is 9.75 m. (32 feet) long and 1.5 m. (five feet) in diameter and shaped like a cylinder.

Gemini astronauts carried out a large number of scientific, technical and engineering experiments which added up to a considerable increase in space knowledge.

Astronauts took photographs from their orbiting spacecraft of the zodiacal light—a disk of light around the sun which cannot be seen from the Earth. Ultra-violet pictures taken of stars told us much about their physical and chemical compositions, and photographs of Earth and its cloud cover, provided a wealth of new information for geographers, meteorologists, and

oceanographers. Spacecraft photographs indicated that sensing from orbit might be a good way to locate and observe Earth's resources: water, minerals, oil and others.

Micrometeoroid and radiation experiments carried out during Gemini flights increased understanding of what to expect from these space phenomena.

The gravity-gradient experiment, in which Gemini and Agena were stabilized at opposite ends of 30.5 m. (100 foot) long tether, was an important step toward operation of future manned stations in Earth orbit.

The Gemini program: (1) demonstrated the feasibility of long-duration space flight for at least that period required to complete a lunar landing mission; (2) perfected the techniques and procedures for achieving rendezvous and docking of two spacecraft in orbit; (3) achieved precisely controlled reentry and landing capability; (4) established capability in extravehicular activity; and (5) achieved the less obvious, but no less significant, flight and ground crew proficiency in manned space flight.

(*Next: Space Research for Use on Earth.*)

Gemini Space Pioneers—The Gemini 11 spacecraft crewed by astronauts Charles Conrad and Richard Gordon is hoisted aboard the recovery ship at completion of a three-day Earth orbital mission in September 1966. The astronauts docked their spacecraft with an Agena target satellite and used its primary propulsion system to reach a record altitude of more than 850 miles on a 71-hour flight.

Headquarters Officer Promoted and Transferred

Bradley

Ann Bradley, until late July assistant executive officer to the Deputy Administrator of NASA, became director of Administration and Management Support at the Hugh L. Dryden Flight Research Center recently.

In her new post, Bradley will be responsible for administrative and management support of operations at the center, including the shuttle carrier aircraft tests and the orbital approach and landing tests for which extensive preparations are now underway. Her responsibilities include financial management, procurement, personnel management and institutional support.

Bradley joined NASA in 1973 as a personnel management specialist at NASA headquarters. From 1974 to June 1975, she attended Princeton University under NASA's Executive Development Program as a Princeton Fellow in Public Affairs. She became Dr. Low's executive assistant last year.

Before coming to NASA, Bradley was employed by the Office of Economic Opportunity and the Agency for International Development. A native of Washington, D.C. she earned her B.S. degree at George Washington University.

Space Industrialization to Be Studied

Contracts will be awarded this fall to two types of companies invited by NASA to make proposals for studying a broad concept of future research, development and operations collectively known as "space industrialization."

Space industrialization is defined as space activities undertaken primarily for the production of goods and services of major economic benefit. This next phase of the space program is the logical extension of much of the space work undertaken to date—mostly for scientific or exploratory purposes.

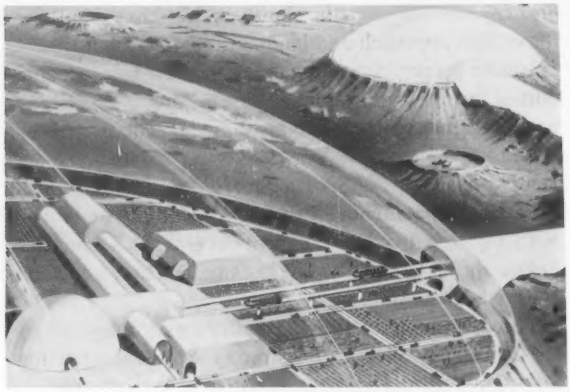
The Marshall Space Flight Center, working under the direction of the NASA Office of Space Flight, expects to award contracts for two parallel studies designed to lay the necessary groundwork for an evolutionary space industrialization effort covering the three decades from 1980 to 2010. One contract will be awarded to an aerospace firm, the other to a research or "think-tank" company.

The main objective of the study is to develop an evolutionary space industrialization program to lead from Shuttle-Spacelab and early space station experiments to permanent, practical and commercial use of space.

The factors to be considered include electrical-power generation and those manufacturing processes that can be accomplished only in the weightlessness of space, or can be done far better in space than on Earth.

Subjects under study will encompass manufacturing, chemicals and medicines, development of new materials and processes, new communications systems, weather services, new Earth resources development, the ultimate movement of people into space for tourism and other purposes, and the eventual industrialization of the Moon.

The proposed work is divided into two phases, each taking about eight months, and the contracts will be in amounts of about $200,000 each.



Bases in Space for Earth People?—One of the most intriguing possibilities in prospect for man in the centuries ahead is that of using some of the neighboring planets to serve the future needs of man for living space and materials. This is an artist's concept of a space base that uses solar energy as a source of power for farming.

Airship Remodeling under Study

Blimps of the future may be able to perform heavy-duty and other kinds of airborne chores instead of merely hovering over ocean resorts and football fields. Technology approaches and potential benefits of such aircraft are under study at NASA's Ames Research Center under a contract with the Goodyear Aerospace Corp. of Akron, Ohio. The program was launched two years ago.

Some of the approaches under study were discussed recently at a California press conference. One concept envisions blimps as possible short-haul transportation systems that would travel quietly and economically, with only minor contamination of the environment.

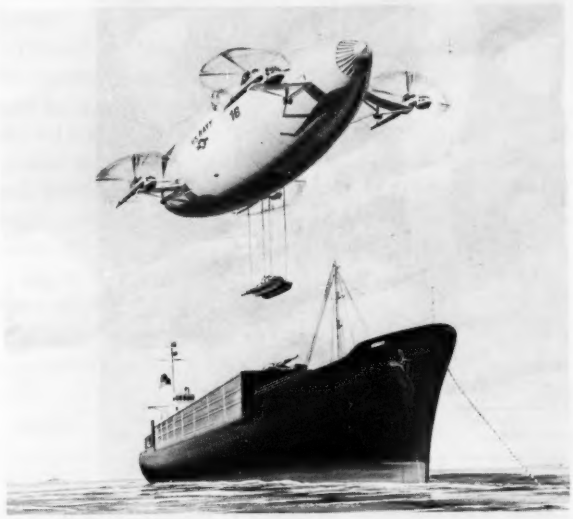
The vehicle under consideration might be used as a feeder airliner. It would be 60 meters (200 feet) long, would carry 80 passengers, cruise at 160 knots (176 miles) per hour, and land and take off vertically. Power would be furnished by four turboprop engines driving large prop-rotors that could be tilted upward for takeoff and landing.

Another concept is for a combination helicopter and airship capable of swinging objects as big as houses through the sky. Dr. Mark Ardema, technical manager of Ames' airship program defined the vehicle under study as functioning like a helicopter but able to lift enormous weights. The research model employs a blimp-shaped helium bag over an H-frame with a giant rotor at each corner. The dirigible—buoyed by inert helium gas rather than the volatile hydrogen used in earlier models of the 1920s and 30s—would hold some 75,000 cubic meters (2.5 million cubic feet) of gas, or about 15 times as much as that carried aboard the familiar Goodyear blimps.

Program scientists say that with such a helium-buoyed crane, engineers could build equipment of prodigious size at factories, then airlift them into place—items such as modular houses, power-plant components and pumping equipment, Similar gas-propelled vehicles could be used to load and unload ships anchored off coasts where no ports are available.

"We did our studies with a 75-ton payload, but that's just the nominal value," Ardema said. "Ultimately, if we could justify it, we could go all the way up through 450,000 kilograms or 500 tons."

A third concept is military, making wider use of blimps for aerial reconnaissance, in a resumption of customs established by the Navy during World War II. Airships might also serve as transportation systems for military material to be moved over beaches to shore points.



Futuristic Shipping by Air—An artist's concept of how a dirigible might be used for shipping and delivering large objects to ships or to installations not served by other transportation systems. The blimp under study at NASA's Ames Research Center would employ four helicopter rotor systems supported by a dirigible hull of 75,000 cubic meters (2.5 million cubic feet) displacement.

Minority Business Awarded Contract

A contract worth some $750,000 for janitorial services at Wallops Flight Center recently was awarded to Wharton Worldwide Services of Parksley, Va. The negotiated fixed-price contract with option periods requires the services of 20 people to carry out the stated duties.

Award of the contract entailed the special efforts of Elton R. Scott, Wallops' minority business specialist, who worked with Wharton (at the time employed by an aerospace contractor at the center) and the Small Business Administration to help gain program certification as well as financing for the business enterprise from private institutions.

NASA Awards Contract—Shown at contract-signing ceremonies at the Wallops Flight Center are (l. to r., standing): Abraham D. Spinak, associate director at Wallops; Elton R. Scott, minority business specialist; James J. Hunter, contract negotiator; Robert L. Krieger, center director; and Robert E. King, director, Office of Industrial Relations, NASA headquarters. Seated are Cornell Wharton, president of Wharton Worldwide Service (left) and Louis T. Birch, procurement officer at Wallops.

Viking and Life on Mars

Editor's Note: This is the second in a six-part series by Dr. Carl Sagan, director, Laboratory for Planetary Studies, Cornell University. His text was completed, obviously, before Viking reached Mars.

In the summer of 1976, if all goes well, an epochal event in human history will take place—the first search on the surface of another planet for extraterrestrial life. Two unmanned intelligent machines named Viking will make landfall on the Red Planet and proceed to search for life. Their activities will be monitored from Earth.

New information can be transmitted to the Viking Landers, their memories and instructions can be programmed. They will be like hands and eyes, ears and noses and mouths, set down on Mars and connected to Earth via a radio link tens of millions of miles long.

The bulk of the Viking Lander is shaped like a stubby triangle with projections both up and down. Extending downward, there are three legs that will absorb some of strain of the landing impact; extending upwards, a variety of scientific instruments, power sources, and antennae.

Viking has seismometers to listen for the rumble of marsquakes. If any are found, we will have acquired information of vital importance for understanding the interior structure of the planet and its evolution. Does Mars have a crust, a mantle and a core like the Earth? Is it geologically active as its numerous immense volcanoes suggest? Some of these questions can be answered even with a very low level of seismic activity on Mars. If we are very lucky, there may be a major marsquake during the year-long operational lifetime of the Mars landers. Our knowledge of the deep interior of the planet might then be enormously increased.

Viking has a set of meteorological instruments to determine wind speed, atmospheric pressure and temperature, the sorts of measurements that terrestrial weather stations routinely make. But now we will have a weather station at two locales on the planet Mars.

Beginning in the summer of 1976 and lasting for about a year we may even have a Martian addendum to the weather report on the evening news: "The high today in the United States was in Needles, Calif. where the temperature was 33 degrees Celsius (95 degrees Fahrenheit); the low in Duluth, Minn., was minus 23 degrees C (minus 10 degrees F.). On Mars, the mid-day temperature in Chryse was minus 9 degrees C (plus 15 degrees F.); but the pre-dawn temperature in Cydonia was minus 113 degrees C (minus 180 degrees F.). Skies are expected to be clear tomorrow in Cydonia but gusts of up to 225 kilometers per hour (140 miles an hour) can be expected in Chryse."

Viking is equipped with an intricately designed sample arm which will extend out to some previously selected spot as much as three meters (10 feet) from the lander, and, with a kind of jerky backhoe and very noisy motion, gobble up a handful of Martian surface sand and dust, slowly and creakingly telescope upon itself until it is only a foot or two long, and then swivel about its axis so that the soil sample can be dropped into a set of hoppers on the top of the lander, which lead to a variety of scientific experiments. Inside the wire mesh entry ports there is something like a set of little electric train cars which transport the soil to the appropriate experiments.

A solution to the parodox then becomes evident: The climate of Mars varies. Today Mars is plunged into deep ice-age conditions. But at least once and possibly many times in its past it has experienced higher pressures, balmier temperatures and abundant running liquid water. There are many interesting implications of this idea.

If Mars can undergo such enormous climatic variations, can this shed any light on the climatic variation which the Earth has experienced? Two million years ago the site of present-day Chicago was under glaciers several miles high. Does the Martian experience provide us with some cautionary reminders about how not to change the environment of the Earth? And also there is the question of life. Do those milder early conditions suggested by the channels mean that Mars once had an environment entirely suitable for life? Could there be life on Mars today evolved from those milder conditions and awaiting the end of the long winter?

Before these questions are addressed we must be sure that the channels were in fact carved by liquid water and that the climate of Mars is in fact variable. We need more information. There is no trouble in hiding a dense earlier atmosphere on Mars today. The enormous thickness of the polar caps correspond to a very thick atmosphere. According to one estimate, if the polar cap were vaporized it would correspond to an atmospheric pressure over the whole planet as thick as that on Earth today. But we do not know very well the age of the various polar deposits. Crater counts by the high resolution cameras on the Viking orbiter could help resolve this issue.

There also will be a source of contamination of organic molecules because the retro-rockets of the Viking landing system will produce certain such molecules during landing. But the principal interest is in organic molecules formed in the earlier history of Mars either by biology or by other processes, and organic molecules produced by living organisms on the planet today. It will be the task of the scientists working with the organic chemistry experiment to disentangle all of these possibilities and to characterize whatever organic molecules may exist. The Viking organic chemistry experiment can detect many molecules with an abundance of only one part in a million. It is a marvel of miniaturization containing, in a cubical box 30 centimeters (one-foot) on a side, all of the analytic power of an instrument in my laboratory at Cornell which fills the better part of a room.

Then there are three experiments to search for Martian microbiology. In one, a Martian soil sample is dropped into an aqueous mixture of organic molecules which we hope the little Martians will like to eat. The carbon in this food is radioactively labelled with the isotope carbon-14, which we know from spectroscopic studies is not abundant on Mars any more than it is on Earth.

If Martian microbes find our food tasty and—as many terrestrial microbes do—release carbon dioxide in metabolizing the food, the radioactive carbon dioxide will be detected by a Geiger counter behind a baffle and the rate of generation of radioactive CO_2 radioed back to Earth. This is a very sensitive experiment if it works. But Martian microbes must like the food we send to them and must oxidize it to CO_2 for us to get positive results.

The food molecules sent are not chosen arbitrarily, they are abundant in terrestrial biology and they are commonly produced in the early history of all planets. But there is no guarantee that this experiment will work. For all we know the Martian microbes might find our little gift of food unpalatable and meanwhile be placidly munching on the zirconium paint on the exterior of the spacecraft.

In a second experiment in microbial biology, an unlabelled aqueous nutrient medium is dropped on the soil sample and the subsequent uptake or output of simple gases monitored. If the Martian organisms exchange even relatively exotic gases with the atmosphere this experiment might detect the exchange.

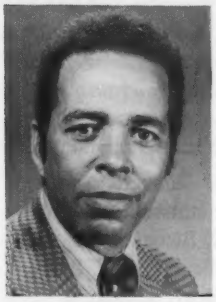
The lander cameras represent yet another life-detecting experiment. They will be able to see about as well as a human being would on Mars, but further into the infrared and with better depth perception. They will examine the nearby rocks, the distant sand dunes, the clouds, the moons of Mars, other celestial objects and whatever other matter is present around the landing sites. The cameras will also examine the Martian soil in the trenches which the arm has dug. If there are Martian macrobes ranging in size from ants to giraffes the lander cameras have a fair chance of seeing them.

The imaging experiments make no assumptions on the biochemistry of Martian organisms. If we see an array of peculiar tree-like forms or a spindly organism 6 meters (20 feet) high, we should be able to detect them independent of their internal biochemistry. Thus the Viking life detection experiments represent a compromise between microbiology experiments of high sensitivity which, however, make many assumptions on what Martians must be like; and television and chemistry experiments of lower sensitivity but which make fewer assumptions.

We do not know what Viking will find. But our previous space experience is that every time we look more closely at Mars we find astonishments and delights.

The year 1977 is the centenary of the finding of the "canals." By 1977 the Viking results should be in. In a hundred years we will have gone from vague observations and wishes disguised as conclusions to the first rigorous detailed and scientific examination of the surface of another planet. Viking represents the opening of a new era in planetary exploration.

New Chief for Dryden Shuttle Program



Gillam

Isaac T. Gillam IV assumed duties in late May as director of Space Shuttle Operations at NASA's Dryden Flight Research Center. Since 1973, he has been program manager of small launch vehicles. His new position involves responsibliity for Shuttle carrier aircraft tests and the orbital approach and landing tests conducted at the center. Gilliam is in charge of the development of test support facilities, the institutional support of test operations, and flight and industrial safety for test operations.

Gillam has been with NASA since 1963 in a variety of posts, including that of Delta program manager from 1968 to 1973. Earlier he served in the U.S. Air Force as pilot, missile launch crew commander and ROTC instructor.

A native of Little Rock, Ark., he moved to Washington, D.C. where he received his B.A. degree at Howard University. He completed graduate level studies at Tennessee State University.

Gillam is a winner of the NASA Distinguished Service Medal for his activities in the launch vehicle program.

Thirty Years with the Government

A short time before Henry F. Auter was appointed acting manager of NASA's National Space Technology Laboratories, he was presented with his 30-year Service Award by Associate Administrator for Center Operations E. S. Groo.

Auter has been associated with the Mississippi environmental and space installation since its inception in 1964, when it was called the Mississippi Test Facility. In early years, it was the site for the acceptance testing and flight certification of the Apollo/Saturn V space vehicle boosters used in America's lunar landing program and used to place the Skylab Space Station in orbit.

Today the $350 million facility, encompassing more than 140,000 acres in Mississippi and Louisiana, is dedicated to environmental and natural resources management research. It also is the testing site for rocket engines to be used in the agency's new Shuttle Program.

Auter is a native of Vicksburg, Miss. He was graduated from Mississippi State University in 1949. He has served in the Army's Combat Engineers Corps and with the U.S. Air Force. Active in community affairs in his native state, Auter has received several awards from Mississippi organizations.

Research Aircraft on Display—Guests at the recent ceremonies held at the Sikorsky Aircraft Co., Stratford, Conn., at which the Rotor Systems Research Aircraft was rolled-out. The RSRA is the first of two helicopters to be used in a joint NASA/Army program to help develop and test a wide variety of existing and forthcoming helicopter rotor systems. Oran W. Nicks, deputy director of NASA's Langley Research Center (far right), observes the cockpit of the first RSRA.

Anniversary Award for Auter—NASA's Associate Administrator for Center Operations E. S. Groo (left) presents a 30-year Service Award to Henry F. Auter at a headquarters ceremony.

Boy Scouts Assemble at NASA Center

The National Space Technology Laboratories at Bay St. Louis, Miss., played host to 2,500 Boy Scouts and their leaders recently. The event, called the Pine Burr Council Bicentennial Jamboree, drew Scouts from all over southern Mississippi.

The Scouts erected a tent city at NSTL and spent three days attending lectures, doing Space Exploration Merit Badge work, and studying space displays and mockups, in addition to standard Boy Scout camping activities.

Jamboree officials awarded the NASA/NSTL a "Good Turn Award Plaque" for its part in the jamboree.

NASA and contractor personnel shared their knowledge of the space program with the Scouts, 1,800 of whom were awarded the Space Exploration Merit Badge. (To qualify, a Scout must complete specific research and reports on the space program. He also is required to build a model of a space launch vehicle, report on a visit to a space laboratory, and give a five-minute talk to his peers on the values of space exploration.)

Scouts on Parade—Some 2,500 Boy Scouts and adults participated in a three-day jamboree held at NASA's National Science and Technology Laboratories. This photo, taken from the top of the central control building at the Mississippi facility, shows the beginning of the parade of scouts.

Did You Know?

Sunday drive-through tours of the Kennedy Space Center have been suspended for the summer. The public is permitted direct access to the U.S. Bicentennial Exposition site in the Launch Complex 39 area, but all other areas are off limits until at least September 7. Drive-through tours of the Cape Canaveral Air Force Station and access to the Air Force Space Museum via Gate 1 are not affected.

Scientists are responding briskly to the Announcement of Opportunity that gives them a chance to conduct an experiment on the first Spacelab mission. The Marshall center has so far examined 323 letters of intent, which propose experiments involving 586 scientists. A tentative selection of experiments will be made by the Office of Space Science in October.

Apollo 14 astronaut Edgar D. Mitchell presided over the planting of a tree sprouted from seeds that accompanied the Apollo 14 crew to the Moon in 1971. The ceremony took place recently as part of the U.S. Bicentennial Exposition on Science and Technology held at the Kennedy Space Center.

IBM (Gaithersburg, Md.) has been awarded a NASA contract with an estimated cost of $24 million to supply the Space Shuttle data processing complex for the mission control center at the Johnson Space Center. The complex will consist of three computers and their peripheral equipment, to be designed, fabricated, delivered, installed and checked out. The cost-plus-award-fee contract with major fixed price elements will be for a period of 44 months.

Fire fighters from across the nation met recently with space officials at the Marshall Space Center to discuss the possible transfer of technology from the space program that would help improve fire fighters' clothing and equipment. NASA and the National Fire Prevention and Control Administration of the U.S. Department of Commerce are engaged in the joint "Project Fires," for Fire Fighters Integrated Response Equipment System.

The Kennedy Space Center has awarded a $19,464,511 contract extension for engineering support services to Planning Research Corp., McLean, Virginia. The 12-month cost-plus-award-fee extension provides for the company to continue design engineering support activities for one year. Work is performed at the Kennedy center, the Cape Canaveral Air Force Station, the Dryden center, and the Western Launch Operations Division.

Computer Sciences Corp., of Falls Church, Va., has been selected for negotiation of a contract for a wide range of technical support services at the National Space Technology Laboratories for NASA projects and those of other tenant agencies. The contractor's proposed cost for the two-year cost-plus-award-fee contract is about $6 million. Three additional one-year extensions will be part of the contract.

The Johnson Space Center used its space environment simulation chambers to dry irreplaceable records and documents damaged in a flood at Houston last June. Included were medical records from a hospital, highly valued books from an art museum, and museum records. The drying technique was first used by the McDonnell Douglas Aircraft Corporation when Air Force records were water-damaged during a fire in St. Louis.

A contract for $3,926,600 has been awarded by the Kennedy Space Center to the Frank Briscoe Co., Inc. of East Orange, N.J. for construction of the second phase of the Space Shuttle Orbiter processing facility. The contract is in addition to one for $8,733,300 awarded last year. KSC is the prime launch and recovery site for the Space Shuttle.

A bill passed by the Maryland General Assembly was signed recently by Gov. Marvin Mandel authorizing a study of how the state can make use of NASA's water hyacinth waste-treatment system to purify streams and lagoons. The study will be conducted by Maryland's environmental services unit. The water hyacinth program has been underway for about two years at NASA's National Space Technology Laboratories in Mississippi and Louisiana.

A 4,600-square-meter (50,000-square-foot) Systems Engineering Building recently was dedicated at the Langley Research Center in ceremonies that also included dedication of the Technology Utilization House (see NASA *Activities* for April 1976). The new building was designed for energy conservation and for compatibility with the solar energy test facility. The solar collector array of 1,380-sq.-m. (15,000 sq. ft.) and a backup steam converter provide the energy for building, heating and cooling. Solar energy is expected to provide about 75 percent of the annual requirements.

Minority opportunities in the aerospace program was the main focus of a three-day aerospace symposium held recently at New Mexico State University, Las Cruces. Faculties from 14 colleges and universities having a high percentage of Hispanic and native American students sent representatives. The symposium was held by the university in conjunction with NASA. It featured workshops and exhibits designed to encourage minority students to consider careers with NASA or otherwise in the space industry. ■ ■ ■ ■

Presidential Congratulations—Hurley Hansen, a NASA employee at the Dryden Flight Research Center flight operations office, is given a personal letter from President Ford in recognition of a suggestion that will save an estimated $6,170 per year. Hansen suggested rebuilding liquid springs for the center's F-104 aircraft within the facility instead of sending them out for repair. Presenting the award is center director Dr. David R. Scott. Standing to Hansen's left is chief of flight operations John Manke. At far right is Larry Barnett, chief of research vehicle maintenance.

Space Industrialization Meeting

The keynote speaker for a two-day Symposium on Space Industrialization held recently at NASA's Marshall Space Flight Center, was John H. Disher, director of advanced programs for the NASA headquarters Office of Space Flight. Disher was introduced by center director Dr. William R. Lucas. The Alabama Section of the American Institute of Aeronautics and Astronautics and the Marshall center co-sponsored the event.

The potential for space industrialization, which promises to become reality when the Space Shuttle becomes operative during the 1980s, was studied extensively in four symposium sessions that dealt with space habitats, space transportation, space processing and solar space power.

Helicopter Research Stressed

In a move to strengthen helicopter research and development and to provide a focal point for industry participation and program management, NASA Administrator Dr. James C. Fletcher recently named the Ames Research Center as the lead center for the program.

Research needs were evaluated by a specially appointed NASA Helicopter Management Advisory Group which stressed the need for significant technical improvements in helicopters if U.S. manufacturers are to realize their fair share of the projected world market for civil and military vehicles.

Ames, supported by the Lewis and Langley centers, will provide comprehensive direction to the program and carry out research in aeromechanics, which includes technology integration and large-scale testing and simulation. Langley will perform research in structures and materials, avionics, and noise. The Lewis center will carry out research on propulsion as it relates to engines, gearing and helicopter transmissions, and shafting.

Such assignments of responsibility will best use capabilities present in NASA centers. Fletcher noted that the naming of Ames as the lead center also will preserve the close working relations and effective cooperation that exists between NASA and the Army's Air Mobility and Development Laboratory, located at Moffett Field in California.

The moves place NASA in a strong position to support the anticipated increase in helicopter research and development activities to meet advances in foreign competition for civil and military sales.

Oceanographic Office Moves to NSTL

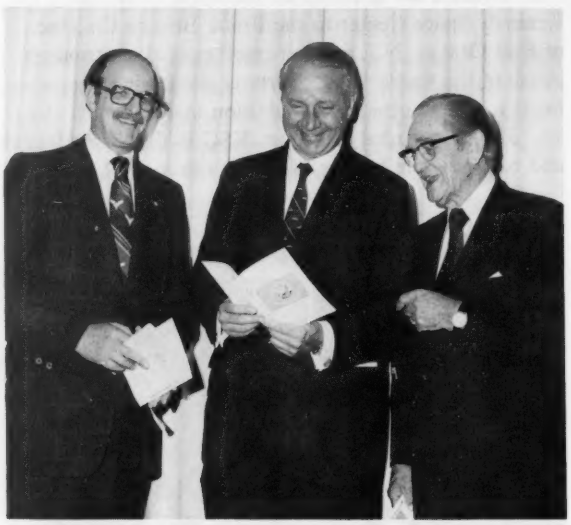
The U.S. Navy became the largest single tenant at NASA's National Space Technology Laboratories when some 1,300 civilian and military employees of the Naval Oceanographic Office were transferred to the Bay St. Louis (Miss.) facility in July 1975. The Naval unit formerly was located in Washington, D.C.

Numerous military and civilian dignitaries were on hand at welcoming ceremonies at NSTL, including Secretary of the Navy J. William Middendorf II, Sen. John Stennis and Rep. Trent Lott.

NASA's Associate Administrator for External Affairs, Herbert J. Rowe, greeted the new tenants and said that NASA and the Navy have enjoyed a long and rewarding association dating back to the early days of collaboration on Project Vanguard, the United States' first purely scientific satellite program. He pointed out that no less than 19 U.S. Naval officers have distinguished themselves and the Navy as astronauts in NASA's manned space flight programs.

Remarking on the NSTL's many contributions to the space program, Rowe said: "We couldn't have built our bridge to the Moon—the Apollo program—without this center's capability of testing the S-IC and S-II stages of the Saturn V vehicle."

He added that "The space technology that is being developed at NSTL by NASA and other Federal, state and private agencies is the latest tool to serve in man's understanding of his place in the universe."



Oceanographic Office Moves to Dixie—Officials meet at recent flag-raising ceremonies held to mark the transfer of the Naval Oceanographic Office from Washington, D.C. to the National Space Technology Laboratories at Bay St. Louis, Miss. Left to right: Herbert J. Rowe, NASA Associate Administrator for External Affairs; J. William Middendorf II, Secretary of the Navy; and Miss. Senator John C. Stennis.

Ten NASA Employees Attend Colorado Convention

The national convention of the Society of Women Engineers held in Denver in late June brought together engineers and scientists of many disciplines from almost every state for discussions and assessments of the state of space exploration.

NASA attendees included Judith Anderson of KSC, Carole A. Bauer and Elsie McGowen of Dryden, Alfred Clinkscales and Oceola S. Hall of headquarters, Gerr Esgar of LeRC, Carole C. Flores of WFC, Sharon L. Henderson and Ivy Hooks of JSC, Annette Laboy of ARC, and Ann Merwarth of GSFC.

Convention participants attended technical sessions on the future of nuclear energy, international solar-terrestrial physics data, climatic change and space technology. They also toured scientific and industrial establishments in nearby areas.

Solar Energy Subsystems to Be Tested

Eleven industrial firms—eight of them small businesses—have been selected by NASA's Marshall Space Flight Center for negotiations to provide marketable solar heating and cooling subsystems such as solar collectors and control systems.

Subsystems acquired as a result of the contract awards will be treated and evaluated at the Marshall center. After evaluations have been completed, the subsystems will be designed into complete solar heating systems that will be installed in residential and commercial buildings throughout the nation to complete the development testing.

Data collected from the test sites will be fed by telephone lines into computers at MSFC, which will serve as a data base for the national program being administered by the Energy Research and Development Administration.

Total dollar value of the contracts is $200,000.

Academic Prizes to Californians—Galileo Scholarships were won by seven high-school students in 1976 in amounts of $500 to $50 Savings Bonds. The awards, presented by Ames Research Center director Dr. Hans Mark, are to assist and encourage careers in engineering, mathematics and the physical and natural sciences among high-school seniors in San Francisco, San Mateo, Sant Clara and Santa Cruz counties. The Galileo Memorial Scholarship Program was established in 1973 by the San Francisco section of the American Institute of Aeronautics and Astronautics and NASA's Ames center as a memorial to the men who yerished in an accident to *Galileo I*, a NASA airborne laboratory. (The crash took place in April 1973; seven NASA men, four contract men, and five Navy personnel were killed.) Seen in photograph are (l. to r.) Louis Haughney of Ames, Ronald Poral, Palo Alto H.S.; Richard Dick of the contractor company ARO, Inc.; Cynthia Nitta, Henry Gunn H.S.; Earl Watson, Ames retiree; Robert Lembert, Aragon H.S.; Kreg Martin, Marian Peterson H.S., Hye Yeong Min, Leigh H.S.,; and Ronald Wurtz, Aragon H.S. Martin and Nitta won $500 each.

Aquatic Blooms as Problem Solvers

Water hyacinths are "bustin' out all over" in the vicinity of NASA's National Space Technology Laboratories in Mississippi, and show real promise of providing the raw material for many useful products. That is the opinion of the NASA scientists who have spent the past two years in experimentation centered on the aquatic plants as a filtration system for purification of polluted waters, as the source of bio-gas for fuel, as a protein and mineral additive to cattle feed, and as a soil fertilizer and conditioner.

The project is called the Vascular Aquatic Plant Project, under the direction of bio-chemist Bill Wolverton. He says, in a preliminary report, that results substantiate theoretical data and that "an expanded research effort might be the start of a permanent solution to present problems such as natural gas shortages, pollution control and control of excessive plant growth in certain water, in addition to producing large quantities of fertilizer from the methane gas-production process."

He cautions, however, that the economics of harvesting are not fully resolved and that a balanced system for total use of the plant must be more fully explored.

The most ambitious experiment to date in the water hyacinth project involves the city of Bay St. Louis, Mississippi. Last year NASA researchers, at the request of city officials, fenced in three acres of a 40-acre lagoon that receives raw sewage from 6,000 households, and planted them with water hyacinths. Earlier laboratory experiments had revealed that the vascular plants (those equipped with a system of vessels that conveys nourishment from roots through leaves) were able to absorb and metabolize astonishing quantities of nutrients and pollutants from domestic sewage waste waters.

The plants, which are particularly fruitful in sewage-laden waters, immediately underwent a prodigious growth in the Bay St. Louis lagoon, soon producing eight to sixteen tons of plants weight (after harvesting) per acre per day. (Growth rate varies depending upon quantities of sewage present in the water.) As the experiment progressed, however, it became apparent that even such a phenomenal growth rate was not sufficient to purify the 40-acre lagoon if the plants remained confined to the allotted three acres.

Accordingly, the planted area was enlarged to about seven acres. Several months later, conditions had improved dramatically. A large part of the heavily polluted, noxious lagoon literally had been transformed into a flower garden. This summer, some 12 acres—more than enough to purify the entire lagoon outflow—were set aside for additional tests. Results will be evaluated later this year.

Last winter, the city of Lucedale, Miss., also called for assistance in coping with water pollution caused by an overaged waste treatment system and population increases. The community was faced with a charge of at least $750,000 for starters, then $100,000 per year for an adequate treatment plant using conventional methods. The NSTL program responded by stocking Lucedale's nine-acre sewage lagoon with water hyacinths which by mid-summer had covered about 65 percent of the lagoon's surface. The outcome of the project looks highly promising. Results will be assessed more closely later this year.

Similar research was conducted in the small Mississippi community of Orange Grove in the summer of 1975, with results much like those in Bay St. Louis, though on a smaller scale. Seven-tenths of an acre of the Orange Grove sewage lagoon was planted with water hyacinths to purify up to half a million gallons of sewage outflow produced daily.

This venture illustrates how valuable the inexpensive filtration system might be to small communities using lagoons for waste disposal. A standard chemical filtration plant of the size needed to remove enough waste products from the Orange Grove lagoon to meet current pollution standards would have cost about $500,000. The water hyacinth system solved the problem for only the few thousand dollars required for stocking and repeatedly harvesting the plants.

In experiments such as those carried out at Bay St. Louis, Lucedale and Orange Grove, NASA's participation is confined to supplying expert personnel to analyze the program, suggest solutions and demonstrate corrective measures, then monitor the system. The community itself bears all other responsibilities.

Another phase of the water hyacinth experiments was concentrated on conversions of the harvested plants into feeding rations for beef cattle, accomplished by drying and grinding plants taken from sewage lagoons into meal. The result is a meal rich in minerals and protein. The processed meal was added to corn silage fed to a herd of feeder steers at the nearby Mississippi State University agricultural experiment station farm.

At the end of the four-month study, weight gain of the animals was assessed and found to be satisfactory, comparable to that realized on a diet fortified with cotton seed meal and soybean meal. Since only a tiny percentage of the plant tonnage produced from the sewage lagoons was used in the experiment, it is not possible for researchers to gauge the amounts that might be required for broader feed supplement ventures. However, it seems likely that supplies would far exceed any foreseeable need. Similar experiments involving dairy cows at Louisiana State University are underway.

Solar Dryer for Aquatic Plants—A prototype solar dryer with solar panels is seen in the background of this picture. The inexpensive drying system is being tested at NSTL, in an effort to reduce the costs of producing cattle feed from dried and ground water hyacinths. One of the NSTL test lagoons containing the plants is in foreground.

Experiments have shown that an impediment to the production of cattle meal is the high cost of fuel for drying the plants after harvesting. An alternative measure under consideration at NSTL in the use of solar energy to reduce drying costs. A protoype solar dryer system has been built and is being tested now at the NASA facility and test results will be announced next summer. Projections suggest that the system will process about 18 tons of wet material every 36 hours. The solar dryer may also be an energy-saving solution for other agricultural needs such as the drying of grains and forages.

A third phase of the NSTL water hyacinth project involves the conversion of the plant into both methane gas and fertilizer, using an anaerobic (growth of bacteria under oxygenless conditions) fermentation process. Experiments conducted in NSTL laboratories demonstrate that one pound of plant refuse can produce about five cubic feet of methane gas, which means that two million cubic feet of gas could be expected annually from each acre of water hyacinths. The significance of such high production rates can be illustrated by noting that the state of Louisiana alone produces more than a million acres of unwanted water hyacinths which, if harvested and processed, could provide more than a billion cubic feet of methane gas daily. This amounts to all the gas consumed annually by more than two million homes in the New Orleans region. Presently water hyacinths are an expensive nuisance often brought under control through expensive and unprofitable methods that sometimes involve the addition of undesirable chemicals to the water system, but under the bio-gas production method residues could be used as an efficient fertilizer and soil conditioner. Production could reach a rate of 0.5 tons daily from one acre of sewage-enriched water hyacinths, free of any heavy metals.

In another type of study, water hyacinths also showed a remarkable ability to filter out heavy metals such as cadmium, mercury, nickel, lead and silver, and other toxic organic substances commonly found in industrial waste waters. Utilizing a zig-zag, canal type of waste treatment lagoon at NSTL, field researchers studied the ability of the plants to detoxify industrial and chemical waste. Test data from the 40-foot wide by 2½-foot deep by 800-foot long lagoon have confirmed laboratory experiments—final effluent from the 25,000-gallon per day filtration system meets or exceeds effluent standards for the NSTL chemical and photographic laboratories' waste products treated in the system.

Plants harvested from industrial waste lagoons obviously cannot be processed into animal feed or fertilizer. They can be processed to produce methane gas. In fact, NASA states that the bio-gas generated from plants containing trace amounts of nickel and cadmium yields a higher percentage of methane gas than plants that do not contain those metals.

Natural Water Purification—Bill Wolverton, bio-chemist in charge of the Vascular Aquatic Plant Program at NSTL, monitors lagoon water which has been purified by the biological action of water hyacinths. The plants were introduced into NSTL specially created lagoons in 1975.

A large number of spin-off projects have been undertaken or are under consideration by a variety of organizations and individuals in this country and abroad as a result of the worldlwide interest in the water hyacinth stimulated by NASA's experimental program. These include:

- A workshop sponsored by the Sudanese National Research Council and the U.S. National Academy of Sciences, whose purpose was to survey the problems engendered by overgrowth of water hyacinths in the White Nile River. NASA investigators, with a group of scientists from the U.S. and other countries, visited the Middle East last December to study the problem. The scientists collectively recommended a series of corrective measures, including those developed in the NASA program to harvest, then convert the plants into fuel.
- Examination of the premise—by an Environmental Protection Agency unit and NSTL program managers—that water hyacinth plantings might constitute a new detection system for assessing percentages of heavy metals present in various bodies of water. The system envisioned would scrutinize the metals stored in the aquatic plants rather than quantities found in water. Such a system might even be adaptable to outflows from thermo-nuclear plants.
- Establishment of water hyacinth filtration systems in sewage lagoons in communities in Florida, Louisiana and Mississippi as a means of restoring polluted waters.
- A study of advisability of a summer test program in the Washington, D.C. area in which a 14-acre lake might be dammed off from the Anacostia River and planted with water hyacinths in an attempt to reverse pollution of the lake and stabilize it for use as a recreational site.
- Studies at NSTL and Louisiana State University of the possibility that another vascular aquatic plant called duckweed can be used as a supplemental filtration system when the water hyacinth surface growth is thinned out in cold weather. NSTL scientists discovered that the ordinarily dormant duckweed flourished in Mississippi lagoons as surface quantities of hyacinths diminished, continued to filter impurities (though at a somewhat reduced rate), and then subsided in growth when the stronger hyacinths flourished again as temperatures rose.
- An effort by gold-mining interests to recover some of the millions of tons of gold "tailings" (refuse left over from mining) thought to be present in Colorado streams adjacent to a large mine now shut down, through the use of water hyacinth plantings in streams and ponds. In the past, the region under study produced large quantities of gold. Theoretically, if gold, silver, or other metals are present in solution (ionized), they can be collected by the plants, which are then processed to extract metals in pure form.
- Beginning experiments in numerous U.S. and foreign colleges and universities that for various reasons regard the water hyacinth as a possible means of achieving solutions to problems related to pollution or energy.

NASA's interest in aquatic vascular plants came about primarily because officials at the 13,500-acre NSTL became concerned about possible pollution of the local environment by the various compounds being discharged into nearby streams by scientific and technological laboratories on the premises. A team of NASA environmental scientists was assigned the responsibility of monitoring levels of potentially harmful wastes such as acids, pesticides, bromides, heavy metals and phenols. The team was charged with devising means to combat the effects of such pollutants and reverse their effects. One of the discoveries was the peculiar ability of water hyacinths to absorb and concentrate toxic metals and metabolize various other chemical pollutants while producing a continuous and massive supply of plant material.

NASA's water hyacinth project has aroused worldwide interest and has stimulated a number of similar experiments in other regions in the U.S. and abroad.

Farewell Memento to Dr. George M. Low—Shortly before the Deputy Administrator left NASA, he attended a farewell party at the Marshall center, at which Dr. William R. Lucas (left) presented a souvenir—a piece of the Apollo Soyuz launch vehicle.

Medical Student Program at JSC and Ames

The Summer Medical Student Intern Program is in its second year at the Johnson Space Center and its first year at the Ames Research Center. The objective of the program is to encourage members of minority groups and women to become interested and involved in NASA's Life Science Program.

Seven high-school students are participating in the program this year. Those at ARC are Sherri Mitchell of Howard University Medical School and Emma Junior, Stanford Medical School. Both are working in the biomedical research division, Life Science Directorate.

The five students working at JSC are Ray Esparza, University of Texas; Patricia Sherron, Baylor College of Medicine (Hispanic); Charles Larkin, Meharry Medical College; Marcus Williams, Howard University Medical School; and Greg Tracy, at Native American.

Lunar Sample Exhibits

The following is a schedule of lunar sample exhibits from mid-July to mid-August:

Florida—USAF Armament Museum, Eglin AFB, July 1-21.
New York—Summer 1976 Bicentennial Astronomy Show, Centerport, July 1-21.

Ohio—Armstrong Air & Space Museum, Wapakoneta, April 1-Sept. 1.

Texas—Houston Museum of Natural Science/History, end of Caroline at Herman Park, Houston, July 15-Aug. 15.

American Freedom Train—Connecticut: Meriden, Aug. 13-15, Milford, Aug. 3-5, New London, Aug. 10-12; New York: Binghamton, July 17-18, New York City, July 27-Aug. 1; New Jersey: Morristown, July 23-25; Pennsylvania: Scranton, July 19-21, Williamsport, July 14-15.

High Flight Bicentennial Mobile Space Museum—California: Torrance, July 24-31, Newport Beach, Aug. 1-7; Missouri: Ashland, Aug. 13-15.

Tennessee Valley Association—Bicentennial Caravan—Tennessee: Jefferson City, July 16; Mayardville, July 17; Carryville, July 24; Oneida, July 25-26; Jamestown, July 27; Livingston, July 28; Celina, July 29; Cookeville, July 30-31; Wartburg, Aug. 1-2; Kingston, Aug. 3; Crossville, Aug. 4-5; Dayton, Aug. 6; Cleveland, Aug. 7-9; Chattanooga, Aug. 10-14; South Pittsburgh, Aug. 15-16.

Long-term Displays

Alabama—Ala. Space & Rocket Museum, Marshall Space Flight Center, Huntsville.

Florida—Visitor Information Center, Kennedy Space Center.

Kansas—Eisenhower Library, 200 SE 4th St., Abilene.

Mississippi—The National Space Technology Laboratories, Bay St. Louis.

New York—United Nations Building, New York City.

Ohio—USAF Museum, Wright Patterson, AFB.

Texas—Johnson Library, University of Texas, Austin; Visitor Information Center, Johnson Space Center, Houston.

Virginia—Visitor Information Center, Langley Research Center, Hampton.

Washington, D.C.—National Geographic Museum; Smithsonian Institution, National Air and Space Museum, Washington National Cathedral.

Radio-Television

(*Released nationally*)

RADIO: Four weekly *Space Story* programs have been released—"Viking Mars Landing (feat. J. S. Martin, Jr.); "Viking Mission Overview" (feat. Dr. Gerald Soffen); "Viking Mars Landing Sites" (feat. Dr. Carl Sagan); "Viking Life Search: Joshua Lederberg" (feat. Dr. Lederberg). One monthly NASA *Special Report* has been released—"A Project Scientist's Preview: The Search for Life on Mars by Viking," featuring Dr. Gerald Soffen, Viking Project Scientist; and "Viking and the Search for Life Elsewhere," featuring Dr. Joshua Lederberg, Stanford University. One set of 10 60-second NASA *Space Notes* announcements on a variety of subjects including Third Century America, Shuttle, TU (Meals for Elderly, medical benefits), Pioneer to Saturn update, etc.

TELEVISION: A 4½-minute and a 90-second film have been released in the *Aeronautics and Space Report* monthly series, entitled "First U.S. Mars Landing."

Spanish-Americans Convene—Image, a national organization concerned with broadening employment opportunities for Spanish-speaking Americans in Federal, state and local governments, held its fourth national convention recently at Dallas. NASA's Spanish-speaking program coordinators took an active part in the proceedings, discussing the agency's goal of parity for Spanish-speaking Americans and its rate of progress toward that objective. Seen in this photo are (left to right): Hermilo Glora, EEO director of Internal Programs; Alfonso Ludi, agency-wide coordinator for Spanish-speaking programs; national Image president Gilbert Chavez; Dora Puleo of the Goddard center; and Leo Villareal of the Johnson center.

Launches for 1976—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
Helios-2	Jan. 15	Titan/Centaur	ETR	Scientific satellite to investigate the properties of interplanetary space close to the Sun. Cooperative with Germany.
CTS	Jan. 17	Delta	ETR	Experimental high-powered communications satellite. Cooperative with Canada.
Intelsat IVA-F2	Jan. 29	Atlas/Centaur	ETR	Comsat communications satellite—reimbursable.
Marisat-1	Feb. 19	Delta	ETR	Comsat maritime communications satellite—reimbursable.
RCA-B	March 26	Delta	ETR	Second RCA (Satcom) domestic communications satellite—reimbursable.
NATO-III-A	April 22	Delta	ETR	Communications satellite for the North Atlantic Treaty Organization—reimbursable.
Lageos-1	May 4	Delta	WTR	To demonstrate space techniques that will contribute to the development and validation of predictive models for earthquake hazard alleviation, ocean surface conditions and ocean circulation.
Comstar-1	May 13	Atlas/Centaur	ETR	Domestic communications satellite for Comsat—reimbursable.
Air Force Test	May 22	Scout	WTR	USAF scientific payload—reimbursable.
Marisat-B	June 9	Delta	ETR	Second Comsat satellite to provide maritime satellite communications—reimbursable.
Relativity	June 17	Scout	Wallops	Scientific probe to test the Einstein Theory.
Indonesia-A (Palapa)	July 8	Delta	ETR	Indonesian communications satellite 1—reimbursable.
Comstar-B	July 22	Atlas/Centaur	ETR	Second domestic communications satellite for Comsat reimbursable.
ITOS-H	July 29	Delta	WTR	Operational meteorological satellite of the National Oceanic and Atmospheric Administration to provide day and night cloud cover imagery—reimbursable.
Navy Transit	Aug. 11	Scout	WTR	Navy navigation satellite—reimbursable.
RCA-C	October	Delta	ETR	Third domestic communications satellite for RCA—reimbursable.
Marisat-C	December	Delta	ETR	Third Comsat satellite to provide maritime satellite communications service—reimbursable.
Intelsat-IVA-C	December	Atlas/Centaur	ETR	Third of a series of improved Intelsat satellites—reimbursable.

NASA Man Is Fairways Champ—Robert E. King (right) took first place with a low gross score of 74 at the Friends of Ireland annual golf tournament held at Rockville, Md. Standing with him are George Meany (left), President AFL-CIO and Paul Burnsky, General President of Metal Trades Dept., AFL-CIO. King has been with NASA for more than 10 years. He is director of the Industrial Relations Office at headquarters. His name has been inscribed on the perpetual trophy shown in the picture and he received a permanent trophy for the event, as well as a set of Arnold Palmer pro style golf clubs.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.

Inventor(s) and Employer(s)	Title and NASA Docket	Patent No.	Installation
Chu, Ting L./Southern Methodist Univ., Dallas, Texas	Fabrication of Polycrystalline Solar Cells on Low-Cost Substrates	3,961,997	GSFC
Dah Yu Cheng, Univ. of Santa Clara, Santa Clara, Calif.	System for Measuring Reynolds in a Turbulently Flowing Fluid	3,964,306	ARC
Ronald F. Reinisch, Hermilo R. Gloria, Ronald E. Goldsberry, Michael J. Adamson, NASA ARC	Ultraviolet and Thermally Stable Polymer Compositions	3,965,096	ARC
Allan J. Zuckerwar, Old Dominion Univ., Norfolk, Va.	Instrumentation for Measuring Aircraft Noise and Sonic Boom	3,964,319	LaRC
William J. Britz, William A. Boshers, James J. Kaufmann, NASA MSFC	Lead-Oxygen DC Power Supply System Having a Closed Loop Oxygen and Water System	3,964,928	MSFC
Frank G. Arcella, Ernest C. Phillips, Richard P. Sprecace, Westinghouse Electric Corp., Pittsburgh, Pa.	Method of Forming a Wick for a Heat Pipe	3,964,902	NASA Resident Legal Office (NRLO)
Kemp L. Parrish, NASA/LaRC	Smoke Generator	3,964,304	LaRC
Donald E. Pizzeck, NASA/LaRC	Connector	3,964,813	LaRC
Michael L. Lampton, Francesco Paresce, Univ. of Calif., Berkeley, Calif.	Resistive Anode Image Converter	3,965,354	NASA Hq.
Leonard F. Deerkoski, Richard F. Schmidt, NASA/GSFC	Switchable Beamwidth Monopulse Method and System	3,965,475	GSFC
Robert K. Yasui, Paul A. Berman, Caltech, JPL, Pasadena, Calif.	Solar Cell Grid Patterns	3,966,499	NRLO
James W. Blue, NASA/LeRC	Method of Producing 1231	3,966,547	LeRC
Robert W. Vaughn, Robert J. Jones, TRW, Inc., Redondo Beach, Calif.	Capillary Flow Weld-Bonding	3,967,091	LaRC

Youthful Trainees at Goddard—This year's participants in the Cooperative Office Experience Program are high-school seniors enrolled in a vocational office training program at their schools. The Goddard center provides clerical training in work related to classroom experiences. After successful completion of the program, followed by Civil Service examinations, the students will be offered permanent employment. Coordinating the program are (standing, far right) Lynn Murphy standing next to Martha Harding, and Bruce Boyd (far left).

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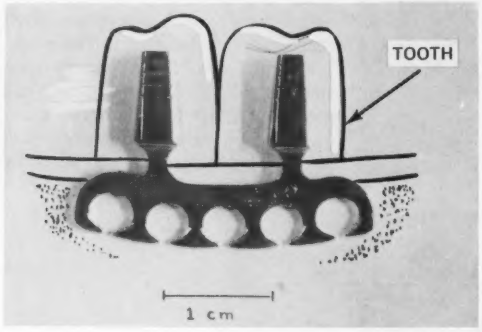
Potential Improvements in Dentistry

The improvement and longer life of supports for false teeth implanted in humans is under study by engineers at NASA's Lewis Research Center. The research, which uses materials technology developed for aerospace, centers on dental implants that are attached to the jawbone and protrude through gum tissue to serve as supports for permanent dentures.

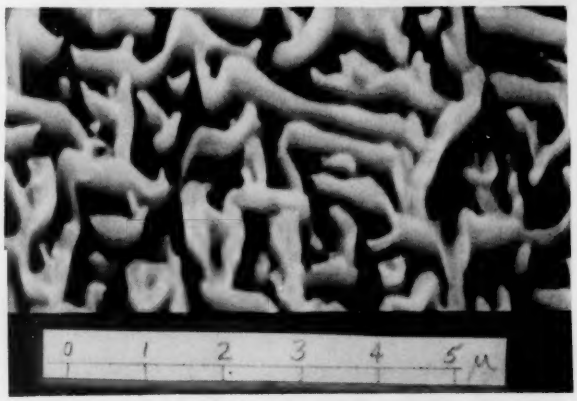
The object of the Lewis center studies—conducted as part of the Ion Beam Applications Research program—is to attempt to simulate the texture and surface structure of natural teeth root through use of ion beam sputtering techniques. Surface sputtering by ion beam has demonstrated that the microscopic structure it creates closely resembles natural tooth root surface. Dental researchers believe that the duplication of the structure could result in improved performance and resistance to disease of the implantable denture supports.

Laboratory procedures expose titanium material samples to bombardment by kilo-electron-volt titanium ions. The ions are discharged from a thruster similar to ones developed for space satellites. Titanium material is preferred for implantation because of its mechanical characteristics and compatibility with body fluids, scientists say.

"Once a desirable surface treatment is attained, the titanium implants will be placed in dogs in a Cleveland-area hospital and the performance of the implants will be evaluated over a long period," explained project engineer Jack Weigand. He added that "Researchers believe that tooth implants modified by ion sputtering techniques could result in long-lasting permanent dentures closely resembling the natural teeth they replace."



Dentists implant new teeth through use of this one-centimeter wide device, which is inserted into oral cavities to become the permanent anchor for replacement teeth. The bottom part of the implant, below the two prongs, is subjected to the sputtering by ion beams.



This highly magnified view of the surface of a titanium tooth implant shows its honeycomb-like appearance after being roughened by sputtering techniques. Researchers believe the rough texture strengthens the bond between tissue, ligaments and bone. Dr. Charles A. Babbush of Cleveland's Mount Sinai Hospital is principal investigator for the NASA project.

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